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Lived values and modal choices in Sweden: an approximation to potential losses from the low-carbon transition in the transport sector

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Abstract

To meet the goals set in the Paris Agreement, the transport sector requires transformative changes, not only in terms of prevailing technologies but also with regards to reducing the need for fossil-based transport and increasing the share of public and active transport modes. Policies to enable this transformation are likely to have differentiated impacts on quality of life across society and have the potential to reproduce or deepen existing inequalities. When identifying potential losers from the low-carbon transition, it is important to consider a diverse set of loss categories, including social support networks and attachments a person has to particular people, material things, places and traditions. A key assumption here is that individuals' perceptions of loss derive from their lived values, i.e., what they consider important in their life. Through a mixed-method approach consisting of a literature review and a survey, this study explores modal choices for realizing activities central to quality of life in Sweden, with a particular focus on societal groups at disadvantage in the transport transition. This article provides new insights on potential losses associated with the low-carbon transition in the transport sector and their distribution across society and reflects on the implications for transitional assistance policy.

Keywords Transport, Low-carbon transition, Quality of life, Lived values

1 Introduction

To meet the goals set in the Paris Agreement, the transport sector's CO_2 emissions in 2050 would need to be limited to about 70–80% below 2015 levels [1]. The International Energy Agency (IEA) estimates that CO_2 emissions from the sector should decrease by more than 3% per year to 2030 to be consistent with its Net Zero Emissions by 2050 Scenario, but in practice, transport emissions grew at an annual average rate of 1.7% from 1990 to 2022 [2]. Decarbonizing the transport sector requires transformative changes, including with regards to transport behaviour [3]. This includes technological substitution, such as through electrification, fuel cells and switching to alternative fuels [1], modal shift towards active and public transportation [4], and a decrease in the need for transport altogether [5, 6].

To drive this change, a range of demand-side measures are available to policymakers, such as incentives for public transport, non-motorized transport, and zero or low-carbon vehicles, eco-driving and other awareness measures, road charges and taxes [7]. Measures to decarbonize the transport sector may impact peoples' everyday life significantly, both positively and negatively [8–10], and they are likely to have differentiated impacts across society, potentially reproducing or deepening existing inequalities [11–13]. Therefore, how to effectively integrate technological changes and economic measures with

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a broader social, institutional and cultural transformation to enable a shift to a low-carbon transport system, while also enhancing well-being and quality of life, has become a key issue in transport and climate policy [14–16].

Given the importance of fairness perceptions for public acceptance of decarbonization policy [17], failure to identify the groups at risk of losing out on the transition and to develop strategies to mitigate those losses could become a major obstacle to any transition [18]. The yellow vests protests in France have effectively illustrated the inherent potential for conflict from implementing low-carbon transition policies perceived as unfair [19]. There is growing recognition that in order to ensure a safe climate, consumption patterns need to evolve without disproportionately affecting disadvantaged population groups [20].

To address this issue, transport-related research has started to explore the distributional implications of the low-carbon transition. However, considerations related to cost, health and access to basic services and employment opportunities have prevailed. When identifying potential losers from the low-carbon transition, it is important to consider a large set of loss categories, taking subjectivity into account [21], including instrumentally valued external resources of a non-financial nature, such as social support networks, as well as intrinsically valued attachments a person has to particular people, material things, places, and traditions [22]. A key premise here is that individuals' perceptions of loss derive from their lived values—what they consider important in their lives and the places they live. These are expressed verbally (as articulated values) and/or through everyday activities (as enacted values) [23]. Another key assumption is that individuals' needs and values, as well as the way they prefer to fulfil these, vary across time and between cultures and groups [24].

In this context, this paper seeks to provide a better understanding of how transportation relates to what individuals value for their quality of life. This is an important step to identify potential losses they may experience due to transport decarbonization policies, and to develop transitional assistance policy, i.e., policies to "mitigate the burdens of transitions that would otherwise be experienced by those adversely affected" [22], p. 903). To do so, this study asks the following questions:

- What activities do individuals in Sweden value for their quality of life?
- What are the modal choices used by individuals in Sweden for doing activities central to their quality of life?
- How do these lived values and modal choices differ for population groups that are particularly vulnerable during the transport transition, such as individuals with low incomes and those living in sparsely populated regions?

As for the study's scope, the choice of focus on Sweden stems from several reasons. Sweden has committed to become fossil free and to have zero net emission of greenhouse gas emissions by 2045 [25]. To reach it, it has set an intermediary, transport-specific goal of decreasing transport emissions by 70% by 2030 compared to the 2010 levels [26]. The intermediary goal does not cover domestic flights, which are covered by the European Union Trade Emissions System (EU ETS). Domestically, transport accounts for 30% of national emissions (40% when including air and maritime transport) [27].

Since 2018, the primary policy tools for driving emission reductions have been increasing the share of biofuels and promoting electric vehicle adoption through a bonus-malus system. However, progress has fallen short of the 2030 goal [26]. Recognizing this, the Swedish Climate Policy Council has emphasized the urgency of making progress in other dimensions of the transition, such as cultivating a more efficient transport society through curbing transport demand and a shift to active (walking and cycling) and public transport alternatives [26, 28, 29]. Although aviation is included in the EU ETS, this instrument does not cover intercontinental flights nor the non-CO_2-effects of air travel [30]. In 2017, the Swedish government adopted a new aviation strategy with emission reduction objectives [31]. Following this, the government introduced two main decarbonization policies for the sector, a biofuel blending mandate in 2017 [32] and an air-passenger tax in 2018 [33].

To accelerate transport electrification, a new strategy was introduced in 2022 [29]. Yet in 2022 and 2023, the Swedish government decided to temporarily reduce fuel energy taxes and to decrease the biofuels blending obligation as energy crisis relief measures while also stopping subsidies for electric vehicles, further jeopardizing the achievement of the 2030 goal [29]. The government also cut the tax on flying from 2025, despite recognising it would lead to an increase in greenhouse gas emissions [34]. As a result, transport decarbonization policy in Sweden appears to become more driven by policy at the European Union (EU) level, such as banning new combustion engine car sales from 2035 [35], and setting deployment targets for electric vehicle charging infrastructure in the EU's main transport corridors [36]. Sweden's Climate Policy Council has warned that the country's current climate policy will lead to increased emissions and calls for more measures to increase the use of non-fossil fuels vehicles and promote a more transport-efficient society (Swedish Climate Policy [37]).

The Swedish Environmental Policy Agency has also highlighted transport decarbonization measures such as reducing demand for transport and promoting electrification and alternative fuels, as well as public transportation and active transportation modes [38].

Such policies may however involve equity concerns in terms of consumer affordability and access to infrastructure [39, 40]. Research has shown that individuals with low income and/or those living in areas with a low population density are particularly at risk of struggling to cope with the implications of transport policy that aims to decrease the use of personal fossil-fuelled cars in favour of more electric vehicles and public and non-motorized transport [12].

Moreover, Sweden has historically demonstrated a strong commitment to implementing policies that aim to promote equal opportunities and improve living conditions. However, recent developments indicate a trend of growing inequalities and an expanding wealth disparity between the wealthiest and the most economically disadvantaged households [41].

We expect that conducting this exploratory analysis for Sweden will prompt pertinent questions and findings applicable to other countries. It can also serve as a blueprint for conducting more comprehensive research on the potential losses and benefits from transport decarbonization policies and how these vary across population segments, considering what people value for their quality of life.

The remainder of this study is structured as follows. Section 2 situates this study in the literature about transport and its relation to well-being, quality of life and social equity, and with regards to the literature about loss in transitions. Section 3 introduces the methods used in the research. Section 4 describes the results of the analysis, focusing on valued activities and modal choices for participation in such activities, including those of two vulnerable sociodemographic groups. Finally, Sect. 5 presents the study's conclusions and policy recommendations.

2 Key concepts

2.1 Transport and its relation to well-being, quality of life and social equity

There has been a growing interest in understanding how transport impacts individuals' overall quality of life and well-being. Although concepts and definitions vary across the literature and are often used interchangeably [16, 42], well-being is fundamentally subjective, referring to an individual's personal experience and satisfaction with their life, while quality of life is broader and encompasses both objective and subjective aspects with regards to an individual's overall standard of living and functioning in different domains of life [16, 43].

Research has shown that transport influences well-being and quality of life in both direct and indirect ways. Directly, transport can influence individuals' emotional and physical well-being during travel or as part of their living environments [44–48]. Indirectly, transport plays a role in enabling participation and access to essential places, activities, and services such as work, healthcare, education, leisure, and social interactions [49, 50]. Having the possibility to travel—through access to transport resources and having the knowledge and skills for using them—can also influence individuals' wellbeing and quality of life [51–53]. On the contrary, transport disadvantage hinders well-being and quality of life [52, 54, 55]. It is thus important to acknowledge the link between transport equity and quality of life.

The literature on transport equity has highlighted how transport infrastructure and policy can reproduce or contribute to address social inequality, "the unequal distribution of, and unequal access to, highly valued and desired material and nonmaterial social goods" [56], p. 6093), and social inequity, the unfair distribution of benefits and costs over members of society, which results from systemic disadvantages and barriers [57]. Key areas of interest here have been how transport policy and infrastructure may facilitate or constrain access to opportunities, and how it shapes exposure to air and noise pollution, as well as road accidents [54, 57, 58]. When it comes to transport decarbonization policy, few studies have assessed their equality and equity implications, either conceptually [59, 60] or empirically [61–63]. One example is Dawkins et al. [12], who identify the group most at risk of losing from the transport and food low-carbon transition in Sweden from a wealth, access and health perspective, namely those who live in areas with a lower population density and higher share of the population at risk of poverty and social exclusion.

Overall, and despite the more detailed understanding of transport's impact on well-being and quality of life, social impacts of transport remain less researched than economic and environmental ones [64]. At the same time, transport planning and policy tends to prioritize economic and technical efficiency [57]. Although equity concerns about the transition are diverse, such as with regards to health impacts or access to charging infrastructure [12, 40], when it comes to transport planning, equity considerations are often limited to affordability issues [65]. This approach fails to account for the wide set of potential losses and benefits of the low-carbon transition on different groups in society.

2.2 Losses in transitions

The question of who wins and loses has been central in the literature about the politics of energy and transport low-carbon transitions [66–69]. However, the concept of loss is seldom examined in depth. Typically, low-carbon transition studies focus on employment and financial losses [70–73], although non-economic losses also received some attention, for instance in terms of identity and sense of community [74–76]. In this context, losses are conceptualized as potential adverse consequences of the transition [11, 22]. However, there is rarely any discussion on how losses come to be perceived as such, and from whose perspective they are considered losses.

The literature about climate adaptation, however, has examined the concept of loss from climate change in more detail. Accordingly, losses result from the failure of adaptation to protect valued objects and objectives from the impacts of climate change [77, 78]. A loss can be economic or non-economic, tangible or intangible [79, 80]. Because losses are shaped by what individuals or collective agents value, they are necessarily subjective and context-specific [21].

Building on this conceptualization of loss, we contend that identifying potential losses (and wins) from the transport transition requires understanding what individuals and societal actors value, and how transport-related transition policies may affect valued objects and objectives. We focus on identifying valued activities that are highly car-dependent, as individuals may not be able to perform them to the same extent they are used or wish to as a result of transport policies. These policies in Sweden and the EU more broadly have tended to emphasize making driving—especially with internal combustion vehicles—more expensive, while aiming to improve public transport and active transport modes, although to a lesser extent [37, 81].

Here, individuals' and social actors' values refer to assigned values (values that individuals attach to objects, people, activities, places or experiences), rather than held values (the principles or ideas that are important to individuals) [21, 82, 83]. More specifically, this study relies on the concept of "lived values", which refer to the "valuations that individuals make, in isolation or as part of a group, about what is important in their lives and the places they live" [23], p. 49). These valuations can be expressed verbally—as articulated values—and/or through everyday activities—as enacted values [23]. Articulated values can be expressed both in terms of satisfaction and frustration [84]. Importantly, individuals' needs and lived values, as well as the way they prefer to fulfil these, vary across time and between cultures and groups [24]. Such concepts are particularly interesting to explore in the context of transport, since modal choices are so individual and context-specific while affecting everyday life to a very large extent.

3 Methods

This study uses a multi-disciplinary and empirical-inductive approach, combining quantitative and qualitative methods.

3.1 Literature review on transport and quality of life

The study's first step was to review the literature to identify how transport contributes to well-being and quality of life, as well as what individuals value about transport, to inform the survey design. We started using a simple search string ((transport* OR mobility) AND (well-being OR quality of life)) and then identified additional relevant studies through snowballing, until we reached saturation. We mapped these against the areas of the EU's framework for Quality-of-Life indicators [85]. Since this framework is very broad, we narrowed down the study's scope to three areas that have received less attention so far in the literature: (1) leisure activities and social interactions, (2) governance and basic rights, with a particular focus on active citizenship; and (3) the natural and living environment.

3.2 Survey

We conducted a single cross-sectional survey to assess individuals' views on lived values and how they relate to their transport modal choices. The survey questionnaire was originally created in English (see Annex 1) and later translated into Swedish. An independent research consultancy firm administered the survey online, handling respondent recruitment and data collection from May 31st to June 14th, 2022.

A total of 1020 people participated in the survey, which was anonymous. The survey's participants were drawn from a web panel provided by Nortstat, comprising of 67,000 individuals living in Sweden, randomly recruited from various locations across the country. The panel processes respondents' personal data in accordance with applicable data protection legislation and the General Data Protection Regulation. Respondents have the right to access their personal data held by the panel at any time, to have their data corrected or deleted and to withdraw their consent to the processing of their personal data. As part of the web panel, all participants received compensation in the form of points, which they could redeem for monetary rewards or donate to charity (see Appendix 2 for details of the selection process).

The selection process for the survey was based on Norstat's nationally representative matrices, considering factors such as gender, age (in 5- or 10-year intervals), and region (NUTS 2 classification) (see Annex 3 for descriptive statistics of the sample). The distribution of respondents is normal when it comes to geographic location, age, sex and income. We divide the income distribution for sampling purposes in the top 10% highest earners, the bottom 10%, and the rest. The survey included the following transport modes: car, bus, train (including subway), taxi, bicycle, walking, motorcycle, electric scooter, and airplane. To present the results, we aggregated the original list of nine transport modes into five categories, aligning with the main dimensions of transport transition policy in Sweden, as described in the introduction: passive mobility (car, taxi, motorcycle, e-scooter), active mobility (walking and cycling), public transport (bus and train), airplane travel, and activities mostly performed at home. E-scooters are classified as a passive mode based on research indicating that they involve significantly less physical activity compared to walking and cycling, even e-cycling [86–88].

The list of activities covered in the survey is derived from the EU's framework for Quality-of-Life indicators (see Sect. 3.1.). They include leisure (i.e., going to the cinema or to live performances, visiting cultural sites, attending sport events or training, going on vacation), social interactions (i.e., being in contact or doing things with family or relatives, being in contact or doing things with friends, participating in non-political volunteering activities, getting help and personal support in case of need), citizen participation (i.e., voting, political citizen engagement activities), and living environment (i.e., visiting a park or being in nature). We also included essential activities that are typically included in transport surveys (i.e., buying food, other forms of shopping, work, studying, taking children to school or nursery, attending health appointments), so that we could compare these different types of activities.

For measuring the importance of enacted values, we use the frequency to which individuals perform a given activity, following Graham et al. [84]. It is important to note that some activities, such as going on vacation and voting, cannot be performed weekly, while others, such as attending cultural events or health appointments, are unlikely to be so. This does not mean they are not important to individuals' quality of life. The emphasis on enacted values serves primarily to complement articulated values and identify activities that are likely to be important to individuals' quality of life even if they do not necessarily express it verbally.

The survey questions were divided into two main categories. The first set explored general mobility habits, while the second set delved into the connection between valued activities and mobility. Here, the survey included measurements for both articulated and enacted values, as well as frustrations—activities that respondents would like to do more of but are hindered from participating in due to mobility constraints. This is because we anticipated that it would provide supplementary insights into their lived values, especially those that may not currently be adequately addressed or fulfilled. This section also investigated drivers of modal choices and experiences in the living environment concerning transport infrastructure. The final three questions provided additional information on the respondents' gender identity, household type, and citizenship, collected from the web panel. The panel information included sex, region (NUTS 2 classification), household size, household and personal income, civil status, educational level, and occupation of the respondents. In this paper, we only present results from questions relevant to the study's scope.

We use inferential statistics to assess whether certain survey variables (e.g., income, age, gender) have a statistically significant association with outcome variables (e.g., travel mode use frequency, frequency of activities). The variables of the data sample are nominal and ordinal. Nominal variables are comprised of values that cannot be ranked or quantified. For nominal data, we report the mode (the number that occurs the most) and mode frequency (number of times a number occurs) [89]. Ordinal variables are comprised of values that can be ranked but not quantified, such as Likert scales. Research shows that these can be an appropriate measure with the assumption of a normal distribution and an adequate sample [90]. To explore associations between nominal and ordinal variables, we apply a Chi^2-test to determine whether two variables have a significant relationship (the null hypothesis H_o is that there is no significant relationship) [91]. The alpha value assumed for the tests is 0.05. A common limitation of the Chi^2-test in research is the sample requirements, however here we assume that this limitation is overcome since the sample is representative and large.

4 Results

4.1 Valued activities for quality of life

Figure 1 illustrates the weighted scores assigned by the respondents to the 17 activities. Participants were asked to rate the top 8 activities based on their importance for quality of life. Based on their ranking, we assign a weight used to calculate the score for each activity. For example, an activity that was ranked to the top by a respondent, receives the maximum weight (8) and the last of the top 8 activities receive the minimum weight (1). Their responses show that activities involving family and relatives are the most important to their quality of life. After family-related activities, we observe a combination of essential and leisure activities, such as buying food, vacation, work, and attending sports events or training occupying the next positions in the top 5. Essential activities

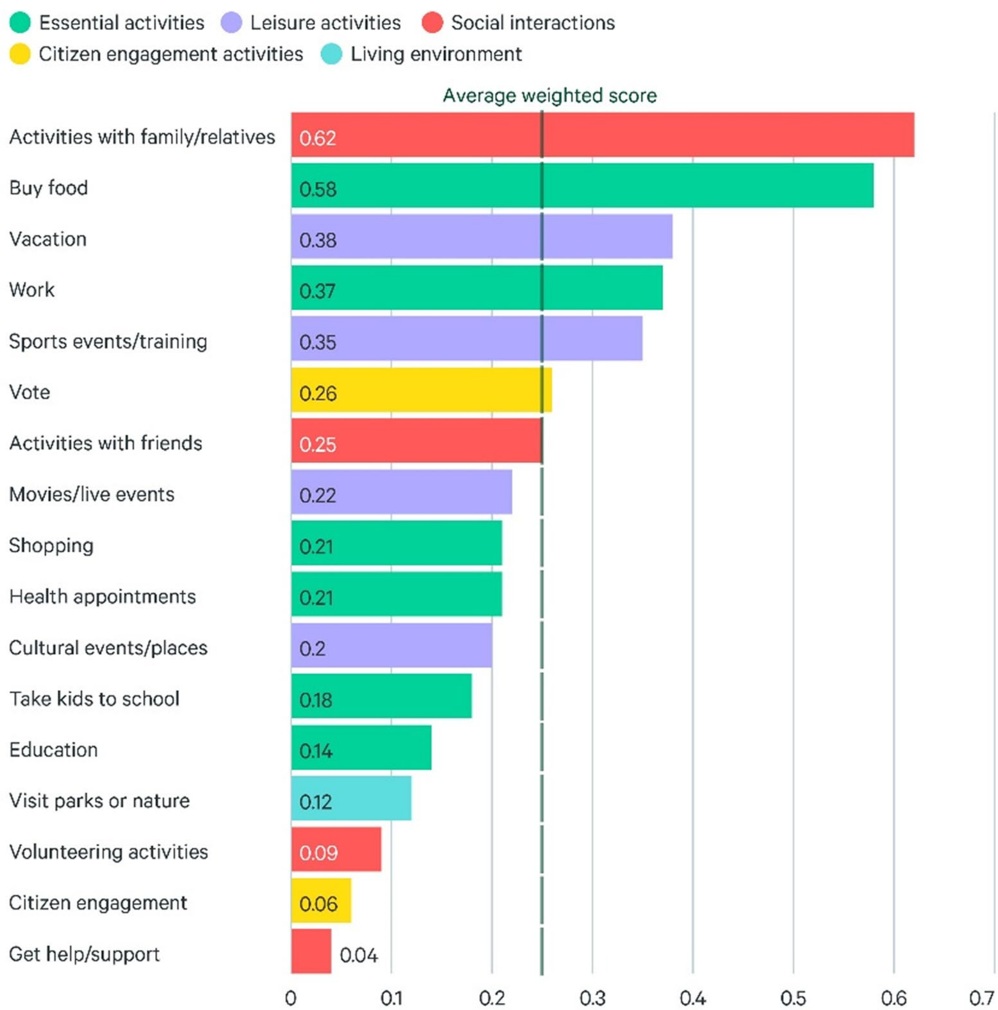

Fig. 1 Activities ordered in terms of importance for quality of life as verbally expressed by the respondents. Average weighted score (weighted ranking divided by sample size) applied on responses to survey, where respondents were asked to rate the top 8 activities for good life quality. The grey dotted line represents the average of the weighted scores (0.25)

generally rank lower in terms of weighted scores, except for buying food and working. Visiting parks or nature also ranks relatively low.

As lived values signal what individuals deem important both in their verbal expressions and through their daily activities [23], the next step is to analyse the frequency with which individuals engage in each activity to identify their enacted values. The findings in Fig. 2 corroborate the significance of social interactions with family, relatives and friends for the respondents. Additionally, the results suggest that visiting parks or spending time in nature holds greater importance in respondents' daily lives than what they verbally articulate.

Figure 3 illustrates the share of respondents that feel hindered from participating in activities as much as they would like due to mobility limitations. The results further confirm that activities with family, relatives and friends are very highly valued. The activities that rank highest however are going on vacation (35%) and visiting parks and being in nature (33%). There is also a relatively high percentage of respondents who would like to do more cultural activities, which matches with the discrepancy between articulated and enacted values that we identified with regards to this activity category. Overall, essential and citizen engagement activities appear less constrained than those in the social interactions, leisure and living environment categories.

Since individuals' needs and values vary across time and between cultures and groups [24], it is essential to get a more detailed understanding of lived values among population groups. To explore this, we focus next on two variables that influence individuals' capacity to cope with the impacts of transport decarbonization: income and population density [12]. Figures 4 and 5 illustrates the

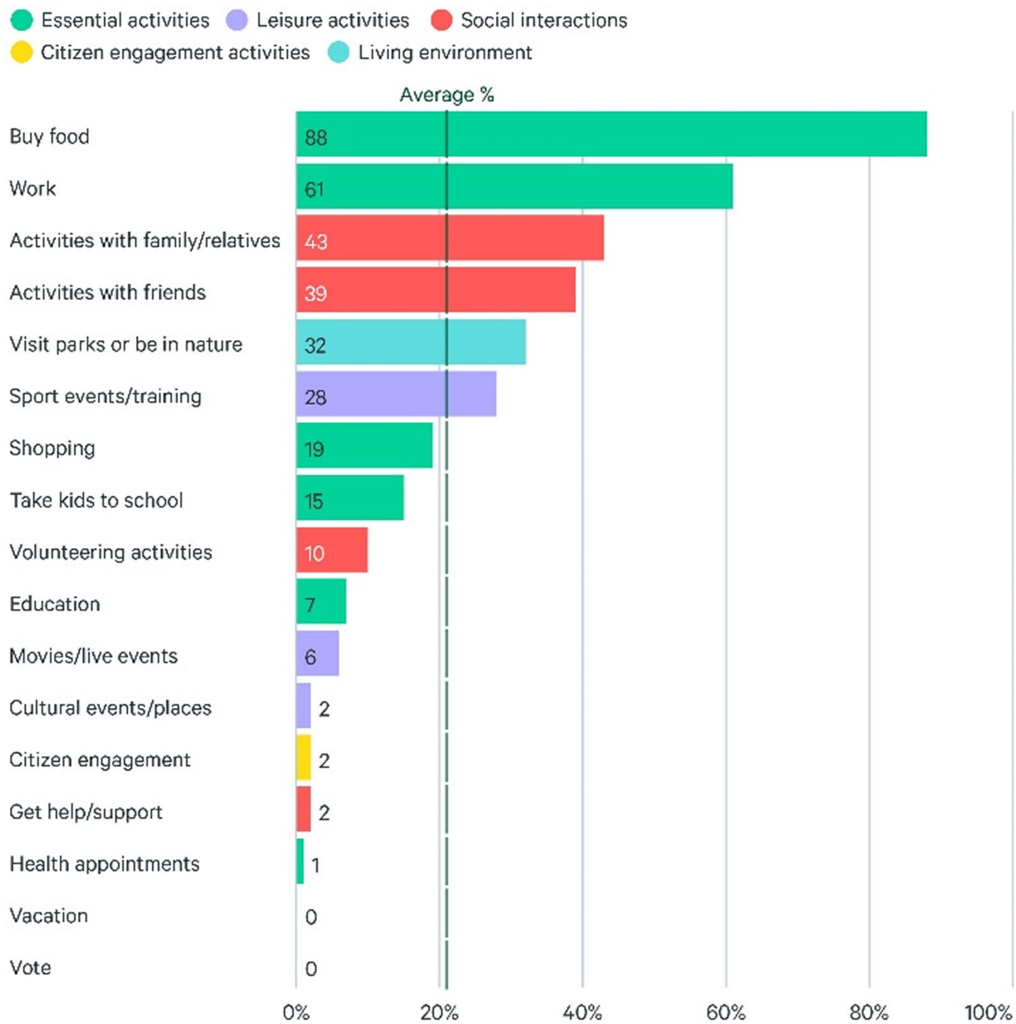

Fig. 2 Activities ordered in terms of importance for quality of life as enacted by the respondents. Percentage of the respondents that answered they perform an activity at least weekly. The grey dotted line represents the mean of responses (0.21). Some activities such as going on vacation and voting cannot be performed weekly, while others, such as attending cultural events or health appointments are unlikely to be so

articulated and enacted values for respondents from a household with a low income and those living in Norrland—a very sparsely populated NUTS 2 region of North Sweden. Figure 6 illustrates the share of respondents from these two groups that feel hindered from participating in activities as much as they would like due to mobility limitations.

Results reveal some differences. With regards to articulated values, both respondents from households with a low income and those living in Norrland rank activities with friends and visiting parks and being in nature higher than the general sample average, showing these activities are more important to these groups than for the overall sample. On the contrary, sport-related activities are ranked lower than for the general population. For enacted values, the results are more alike to those of the general population, although being in nature and activities with friends still rank relatively higher. Enacted values also indicate a higher level of engagement in community activities than the population average, with these groups participating more often in volunteering and citizen activities. In terms of activities constrained by available mobility options, we observe that, similarly to the general population, leisure and social interactions with friends and family rank high. However, visiting parks and being in nature ranks the highest (37%) and is more important than for the general population (33%). For respondents from Norrland, there is a higher level of perceived mobility constraints than the general population for high valued activities, such as those with family and

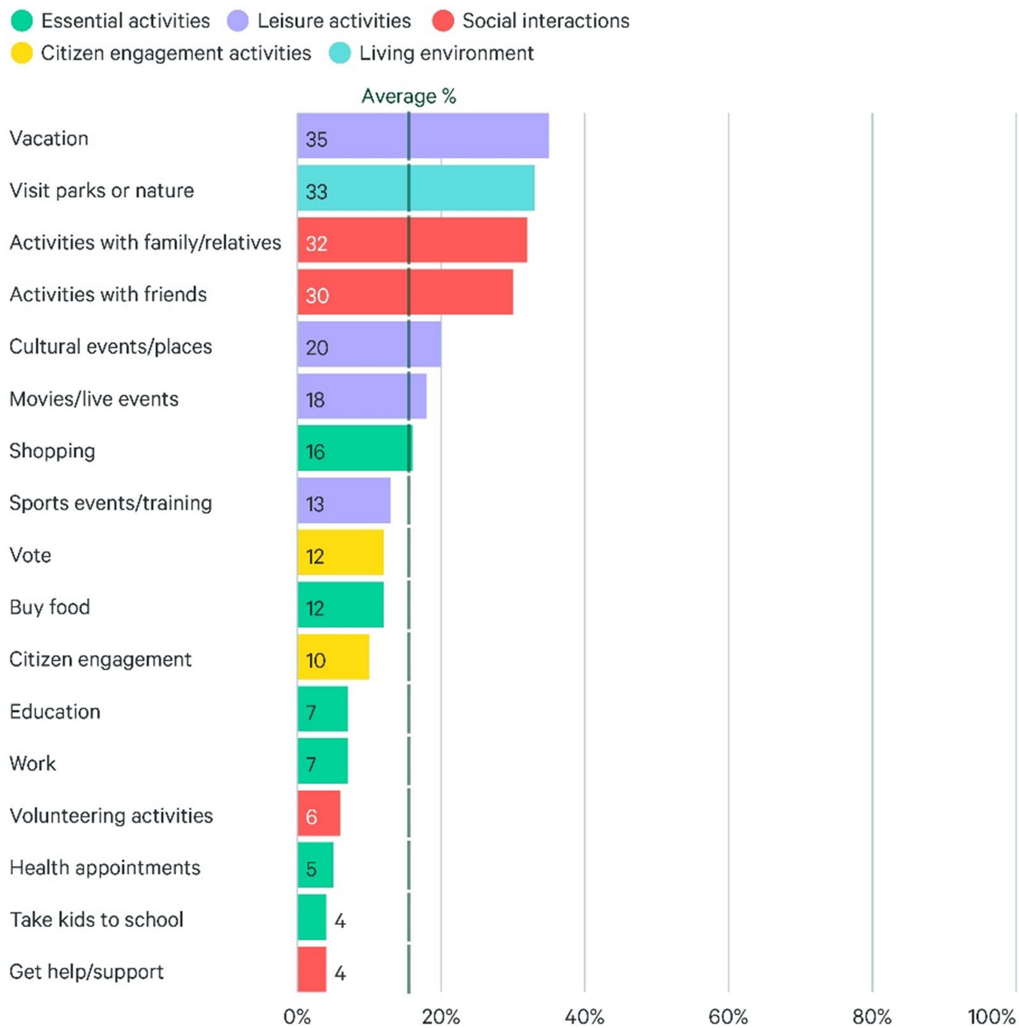

Fig. 3 Share of respondents that feel hindered from participating in activities as much as they would like due to mobility reasons

relatives and vacation. This can be related to time–space restrictions and transport infrastructure limitations [92].

4.2 Modal choices for activities key to quality of life

Figure 7 summarizes the share of activities performed along with the corresponding transport modes respondents use to carry out these activities. Respondents rely primarily on passive mobility for most activities. This is the case for highly valued essential activities, such as buying food (83%) and work (65%), as well as for highly valued social interactions, such as activities with family and relatives (87%) and with friends (81%). Still, buying food and activities with friends also show a high percentage of active mobility (66% and 62%, respectively). Leisure activities are passive mobility intensive too, especially vacations (80%). This is the activity where airplane travel is concentrated, with 61% of respondents reporting using this mode for vacations. Nevertheless, a majority of respondents also use active modes for attending sport events and training (52%), or public transport for cultural activities (53% for movies and 56% for other activities) and vacation (45%). This confirms that mode choices are multi-faceted and both passive and active mobility alternatives can be chosen for the same activity, depending on the context [93].

On the contrary, activities that are less passive intensive, such as education, citizen engagement and volunteering activities, rank lower in terms of articulated and enacted values, except for voting. Here, citizen engagement and volunteering activities are among the ones most often carried out at home (20% and 19%, respectively), after education (25%) and getting help (21%). For comparison, 8% of respondents also indicate that they often work from home. Overall, this suggests that efforts to decarbonize the transport sector, and especially to limit car use, can lead to a sense of loss, if accompanying

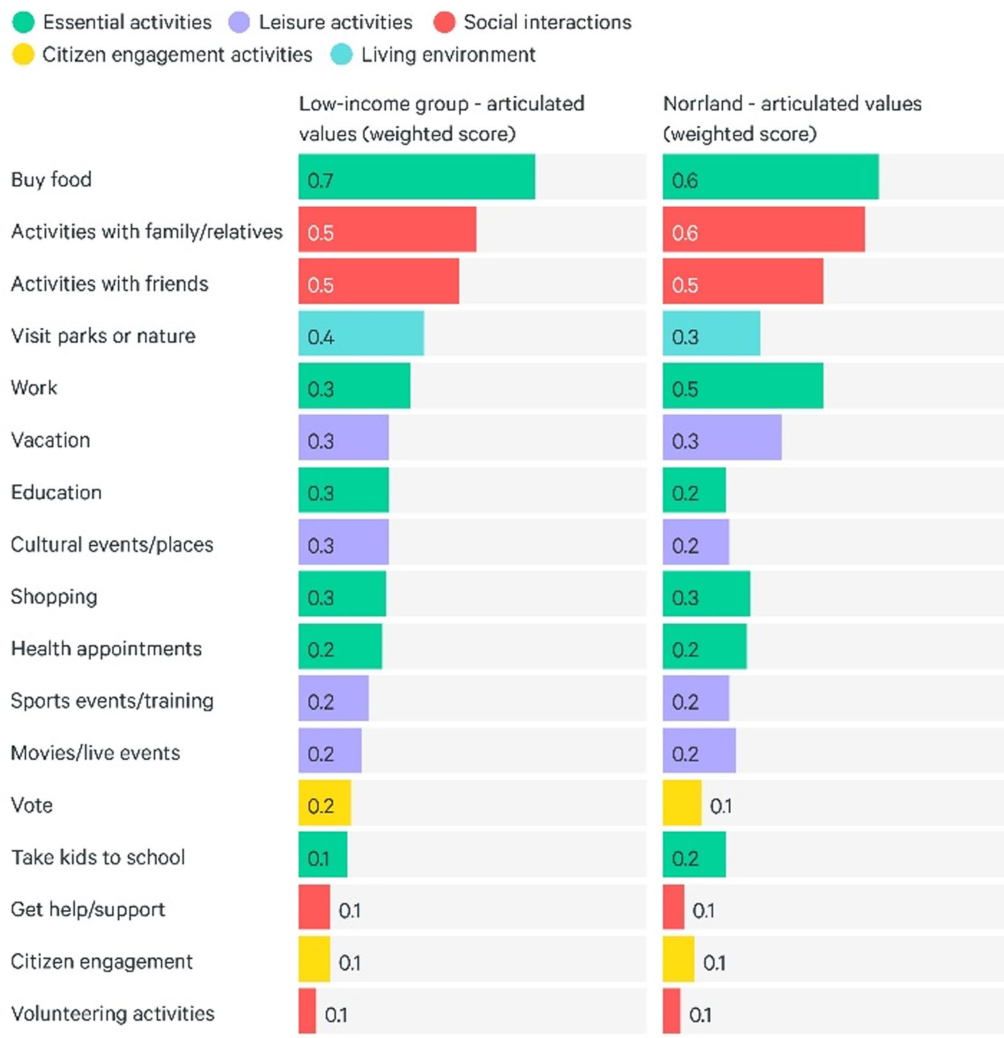

Fig. 4 Articulated values of respondents from a low-income household (left) and who are living in Norrland (right)

measures to improve people's perceived quality of life are insufficient.

Visiting parks and nature is the activity with the highest share of active mobility (91%). This is an example of an activity that is both important for people's quality of life and is easily accessible by foot or bike in Sweden. Still, 68% and 28% of respondents also use passive or public transport modes to reach green spaces.

We report passive mobility shares in Fig. 7, but it should be noted that these are predominantly composed of car use. As shown in Fig. 8, car is the main mode the respondents use in the passive mobility category. Our Chi^2-test is therefore focused on car use and whether there are significant associations with various variables of the sample population.

Figure 9 reports the differences between respondents in groups identified as more at risk of losing compared to the rest of the population. Overall, the low-income group is less reliant on car than the general population. Results from the Chi^2-test show that household income is significantly associated to car use for buying food ($X2$ (26, $N=937$) = 73,25, $p<0.00$), shopping ($X2$ (26, $N=942$) = 51,83, $p<0.00$), and for participating in highly valued social interactions and leisure activities, such as going to the movies and live events ($X2$ (26, $N=833$) = 45,77, $p<0.00$), visiting cultural events and places ($X2$ (26, $N=868$) = 47,71, $p<0.00$), attending sports events and training ($X2$ (26, $N=661$) = 45,09, $p=0.01$), as well as activities with family ($X2$ (26, $N=941$) = 44,66, $p=0.01$) and friends ($X2$ (26, $N=933$) = 56,05, $p<0.00$). Respondents from Norrland rely more on car than the general population for almost all activities, which reflects rural areas' more challenging access to transport alternatives and services, longer travel distances and higher

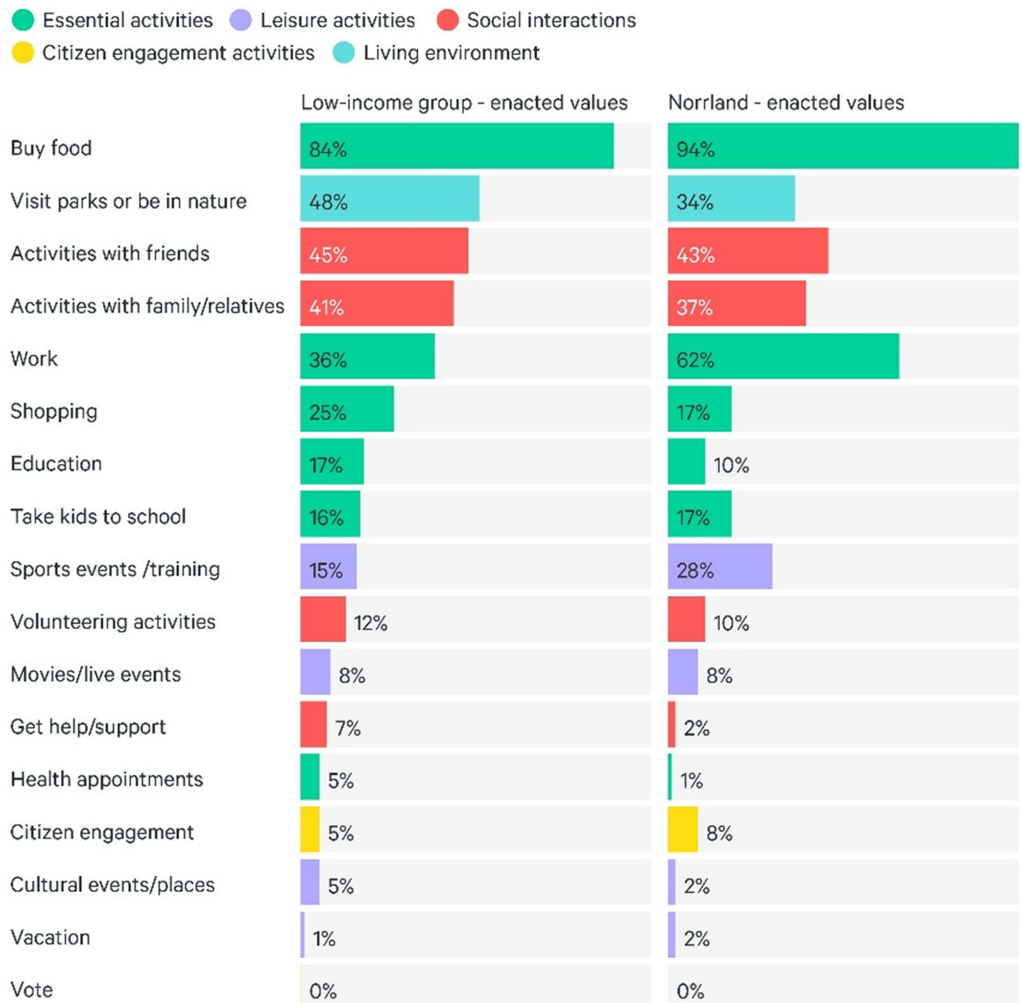

Fig. 5 Enacted values of respondents from a low-income household (left) and who are living in Norrland (right)

car ownership [12, 92]. Highly valued activities among this group are significantly associated with car use, for instance activities with family and relatives, activities with friends, buying food, work, and visiting parks or being in nature.

5 Discussion and conclusions

The transportation sector is crucial in achieving emissions reduction goals. However, given transport's importance for quality of life, it is essential to thoroughly assess the implications of climate mitigation policy [94]. This study uses an innovative conceptual approach and empirical strategy to provide a more detailed understanding of how transport modes relate to what individuals value for their quality of life in Sweden, and how this varies for individuals from a low-income household and for those living in the sparsely populated Northern part of the country. This approach enables the painting of a more nuanced picture of the kinds and magnitude of potential losses that individuals may experience due to decarbonization measures aiming at reducing car use if these measures fail to make valued activities accessible through other modes.

The survey's results indicate that there is a strong overlap between the activities that individuals highly value and the use of passive transport modes, including for aspects of quality of life that tend to receive less attention by both academia and transport planning and policy, such as social interactions and leisure [92, 95]. Citizen engagement activities are less likely to be perceived as a loss, as they are less valued and less reliant on passive mobility overall. The survey results also suggest that visiting parks and being in nature ranks high in terms of enacted values, which aligns with research on health and well-being benefits of green space [96, 97]. This activity type is the one with the highest share of active mobility,

Fig. 6 Share of respondents from a low-income household (left) and who are living in Norrland (right) that feel hindered from participating in activities as much as they would like due to mobility reasons

although over two thirds of respondents also rely on passive modes to engage in it.

This study also points to differences between groups that are particularly at risk of losing from decarbonization policy and the general population. It confirms that individuals from low-income households are less reliant on passive mobility, and this is in line with the fact that income is a determinant of car ownership [98]. For this group, visiting parks and nature ranks highly both in articulated and enacted terms and is the activity the most constrained by mobility limitations. This is consistent with research on urban green space which shows that low-income individuals are more likely to lack access to such space in Europe, despite its positive effects being pronounced for individuals with lower socio-economic status compared to more advantaged groups [99]. For individuals living in Norrland, the findings indicate a higher reliance on passive mobility in general. This is especially the case for essential and community engagement activities. The study also finds a marginally higher level of frustration with mobility limitations for doing activities with family and relatives, and for going on vacations.

5.1 Study limitations

We identify four main limitations in the present study. The first set relates to respondents' sampling. Since we approach the analysis from the perspective of losers and winners from the transition to fossil-free transport, income distribution for the selected sample focused first on the top and bottom 10% of income-earners. The income distribution that was used is the same as the one used by Statistics Sweden (SCB) and is somewhat skewed towards the bottom and the top. Improved sampling techniques are recommended in future studies,

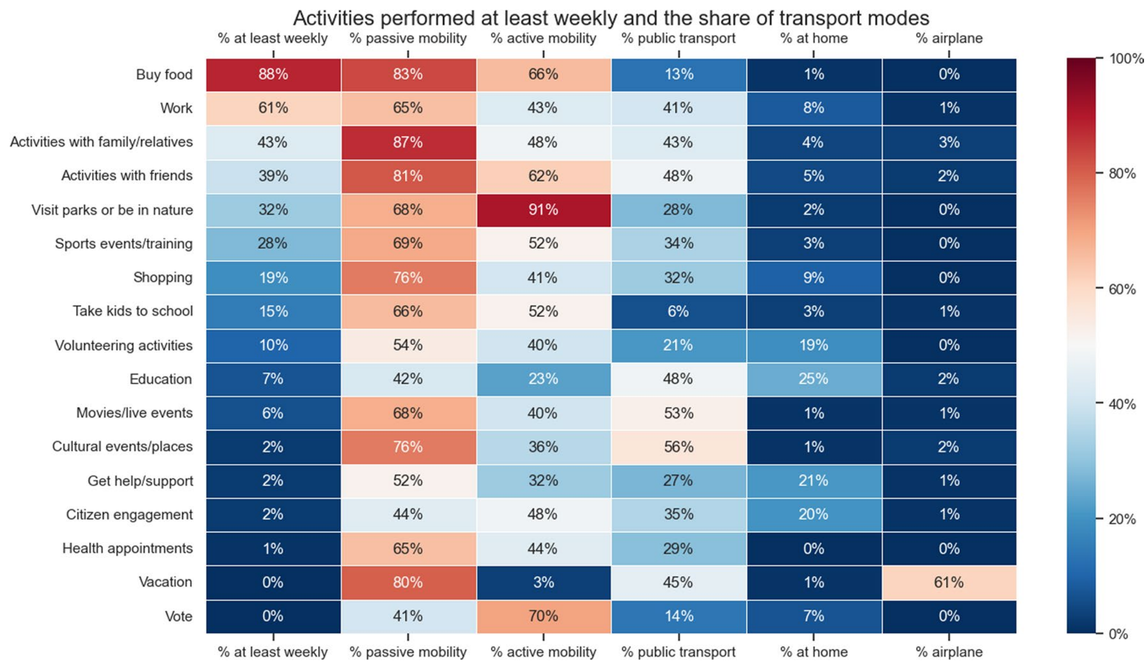

Fig. 7 Share of activities performed at least weekly using passive mobility (car, taxi, motorcycle, e-scooter), active mobility (walking and cycling), public transport (bus or train), airplane, or mostly performed from home. n = 1020. The sum of shares does not equal 100% since respondents could choose up to 3 alternative modes for each activity

enlarging the top and bottom income groups for a better distribution.

Moreover, there is a risk of selection bias inherent to the use of a web panel, as participants self-select to join the panel, potentially leading to a sample that is not representative of the broader population [100]. For instance, certain demographic groups may have limited access to or familiarity with the internet. This is to some extent mitigated by the relatively high level of digital skills in Sweden [101], although gaps remain for older generations, individuals with disabilities, refugees and migrants, as well as individuals living in rural areas [102]. Given that these groups are more likely to be vulnerable in the low-carbon transition, it is crucial to acknowledge that this study's findings may not fully capture the experiences and needs of these populations. Additional research employing other methods of data collection could thus complement it.

The third set of limitations relates to respondent bias, in particular acquiescence and social desirability bias [103]. The self-reporting nature of the data also involves a risk that respondents may not accurately recall information.

Fourthly, the survey was conducted just 14 months after the start of the COVID-19 pandemic, and transport patterns reported in the survey may still have been influenced by it and thus be slightly different from what they used to be before or have become since then. It is important to note that while Sweden recommended that people stay at home as much as possible, no strict lockdown was implemented in the country.

Because of space constraints, this paper does not include the entire set of results obtained from the survey. Instead, it emphasizes the findings most pertinent to the research questions.

5.2 Policy implications

Our study raises a series of issues for transport policy to address in the context of climate mitigation. For instance, it highlights the importance of better incorporating social interactions and access to green space into transport planning, and in cost–benefit analysis guiding decision-making in this sector. Transport planning remains primarily technocentric [104], which contributes to a lack of consideration for the potential benefits of more holistic and balanced approaches to transportation planning.

Ultimately, different policy pathways for decarbonizing the transport sector will respond to individuals' needs and impact quality of life differently. In the context of climate mitigation, it is essential to centre transport policy on how to deliver a better quality of life in a more transport-efficient way, instead of focusing on technology replacement only—such as the idea that replacing all cars with electric cars is alone sufficient to reach climate goals—or indiscriminate transport expansion. This also

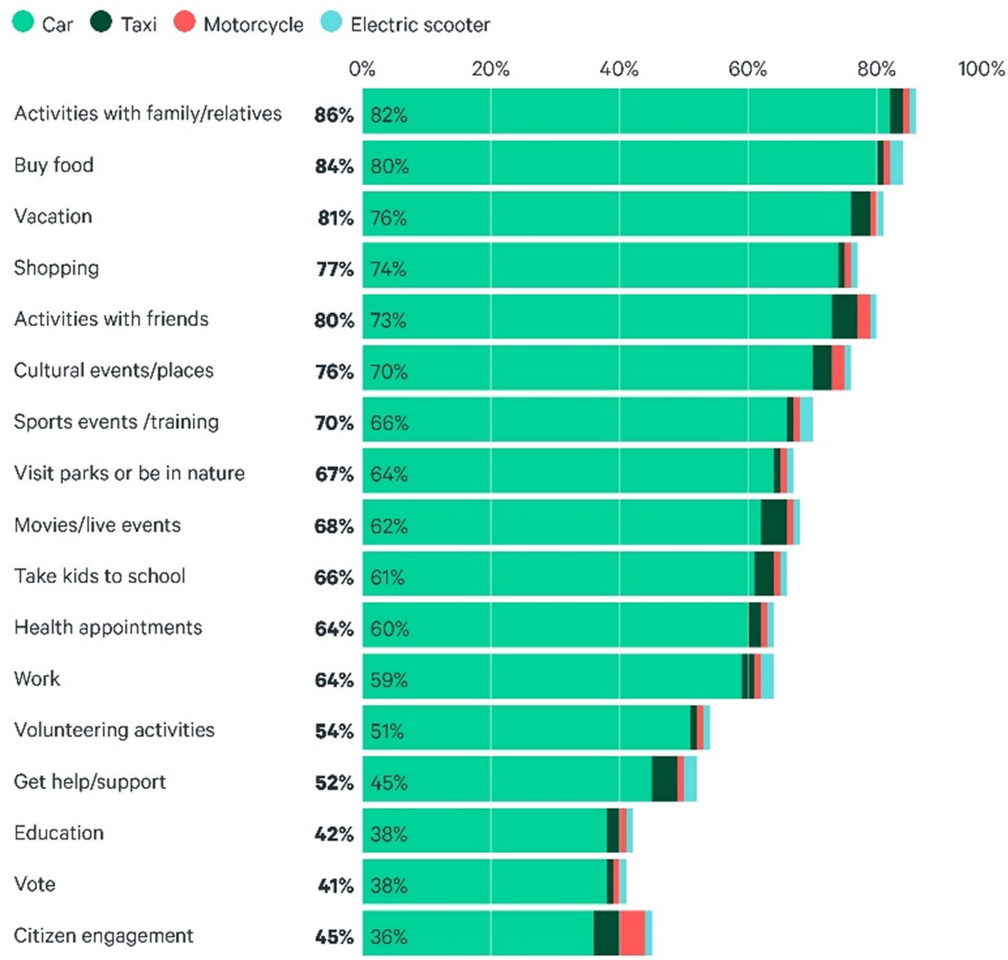

Fig. 8 Break-down of the use of passive mobility modes (car, taxi, motorcycle, electric scooter) per activity

draws attention to the need for an integrated approach—including other policy domains, such as housing and public service delivery—to ensure the transition delivers both the required emissions reductions and a good quality of life.

While this study shows that individuals from low-income households are likely to be less reliant on passive mobility for most activities, this does not mean they face fewer or less relevant potential losses from transport decarbonization. This is because the capacity to cope with transport decarbonization policy also varies among societal groups [12]. When essential services and opportunities require the use of cars, implementing measures that limit their usage or raise their expenses may hinder social inclusion and be perceived as unjust towards already marginalized communities [6]. It is thus essential to accompany transport decarbonization policy with measures to support those who are less able to change their transport behaviour due to structural limitations, and to enhance the quality and accessibility of public transport and active transport infrastructure to improve the quality of life of those already socially and geographically disadvantaged.

Understanding who is at risk of losing from the transition and why is essential to design decarbonization policies that can be perceived as fair and thus more socially acceptable. However, there is a risk that this type of analysis gives way to simplistic and divisive discourses, which emphasize differences and potential injustices, and ultimately hinder policy progress in this realm. This is increasingly the case with discourses on just transitions in Sweden, which tend to conflate urban and rich versus rural and poor [105]. This study also highlights that there are common concerns across groups. There are dimensions of quality of life that are highly valued independently of socio-economic and geographical background, such as social interactions. Highlighting those in low-carbon transport visions and policy discourses could help build wider support for transport decarbonization policies.

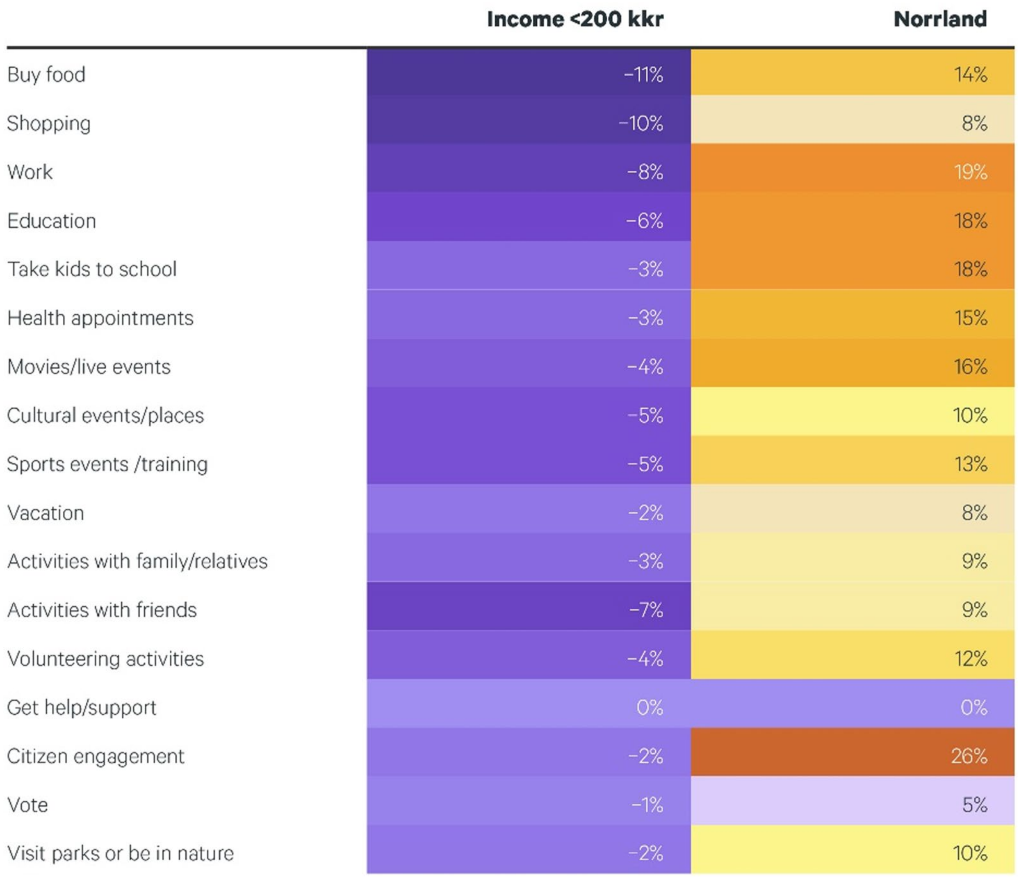

Fig. 9 Difference in share of car use between the general sample and selected sample groups: respondents with household annual income of 200 000 SEK or less (n = 169), and respondents that live in the Norrland region (North Sweden) (n = 87). The colour scale ranges from dark purple to dark yellow, with purple representing a negative difference in passive mobility intensity of activities, while yellow represents a positive difference

By focusing on aspects that individuals find most important for their quality of life, this study also highlights the need to reshape some of the norms and values that sustain high-carbon lifestyles [106]. One key example here is that of vacations, which ranks highly in terms of articulated values and activities limited by mobility constraints in the survey. This suggests a strong association between the idea of vacations and—often distant—travel, although this has not always been the case historically (see [107]). This draws attention to the societal norms that shape what is perceived as contributing to quality of life and how a transformation towards a low-carbon society requires reshaping some of these norms.

Further research could focus on understanding the values and needs of other groups in society and how these compare, such as younger and older generations, how different frames and communication strategies about the costs and benefits of climate mitigation in the transport sector shape fairness perceptions, or what transitional assistance policies may look like in the transport sector.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12544-024-00690-w.

Additional file1.

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Author contributions

Conceptualization: C.S., M.X. Methodology development: C.S., M.X., J.G. Software and data curation: M.X. Data Collection: M.X., C.S. Analysis: C.S., M.X., J.G. Writing: C.S., M.X., J.G. Visualization: M.X. Funding acquisition: C.S.

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Data availability

The dataset supporting the conclusions of this article will be made available upon reasonable request.

Declarations

Competing interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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